International Journal of Civil, Structural,
Environmental and Infrastructure Engineering
Research and Development (IJCSEIERD)
ISSN(P): 2249-6866; ISSN(E): 2249-7978
Vol. 4, Issue 1, Feb 2014, 1-8

TRANS STELLAR • Journal Publications • Research Consultancy

THE EFFECT OF DUMPING SITE LEACHATE ON GROUNDWATER QUALITY-A CASE STUDY OF SRINAGAR CITY, INDIA

MOHAMMAD IBNAM NAZIR[1], SAHIL SUNDAN[2], SAQIB FAYAZ[3], MOHAMMAD ADIL DAR[4] & JAYALAKSHMI RAJU[5]

[1]PG Student, Department of Civil Engineering, N.I.T, Srinagar, Jammu and Kashmir, India

[2]Assistant Manager, N.T.P.C, Uttrakhand, Dehradun, India

[3]Lecturer, Department of Civil Engineering, N.I.T, Srinagar, Jammu and Kashmir, India

[4]PG Student, Department of Civil Engineering, Kurukshetra University, Haryana, India

[5]UG-Student, Department of Civil Engineering, M.S.R.I.T, Bangalore, Karnataka, India

ABSTRACT

Open dumps - unfortunately still the means of disposal of solid wastes in developing countries – where the waste is dumped in an uncontrolled manner, can possess serious threat to the urban environment. Wastes are dumped in an open ground without providing a soil cover except at the closing of the dump. Most of the disposal sites are unfenced and open firing of municipal solid waste is very common. This crude dumping encourages breeding of insects and rodents, and causes several health hazards, migration of leachate into sub surface. The leachate seepage into the groundwater contaminates it with heavy metals such as lead, copper, zinc, manganese, chromium and cadmium and these heavy metals in soils lead to serious problems because they cannot be biodegraded. The problems posed by the open dumping of municipal solid waste on groundwater quality have been demonstrated with the case study of dumping site at **Syedpora Achan** in **Srinagar city, J&K, India** which comprises of 77 acres of land, where the waste has been spread over the land openly for the past 20 years continuously and is further being covered with clay occasionally and use of disinfects are seldom made. Recently in February 2012 open dumping has been stopped and an engineered landfill has been developed by Srinagar municipal corporation through ramky - enviro engineers ltd. and the solid waste is now being disposed in it. This report can also be very useful in checking the effectiveness of the landfill (engineered) in controlling the ground water pollution.

OBJECTIVES AND SCOPE

Objectives of this Project are as under

- To ascertain composition and characteristics of the solid waste dumped at the syedpoora site (Srinagar).
- To ascertain the quality of groundwater near the site due to the effect of dumping leachate.
- To study characteristics of leachate and its effect on the ground water and the local water bodies.

Scope of the Project

Groundwater is important source of water as it constitutes about 95 per cent of the freshwater on our planet (discounting that locked in the polar ice caps), making it fundamental to human life and economic development but is being polluted due to presence of open dumping sites.

This study shows that ground water is very much polluted near the site and cannot be used for drinking as well as for washing purposes as it does not fulfil the requirements of IS 10500-1991.

This study can be useful in checking the effectiveness of an engineered landfill that is proposed to replace the current open dumping.

KEYWORDS: Lead, Copper, Zinc, Manganese, Chromium, Individuals Can Construct, Rely Upon, or Make Significant

INTRODUCTION

Most of the Earth's liquid freshwater is found, not in lakes and rivers, but is stored underground in aquifers. Indeed, these aquifers provide a valuable *base flow* supplying water to rivers during periods of no rainfall. They are therefore an essential resource that requires protection so that groundwater can continue to sustain the human race and the various ecosystems that depend on it. The contribution from groundwater is vital; perhaps as many as two billion people depend directly upon aquifers for drinking water, and 40 per cent of the world's food is produced by irrigated agriculture that relies largely on groundwater. In the future, aquifer development will continue to be fundamental to economic development and reliable water supplies will be needed for domestic, industrial and irrigation purposes.

Yet recognition of the pivotal role of groundwater inhuman development is relatively recent and still patchy. This omission is understandable; water stored in the ground beneath our feet is invisible and so its depletion or degradation due to contamination can proceed unnoticed, unlike our rivers, lakes and reservoirs, where drying-up or pollution rapidly becomes obvious and is reported in the news media.

Groundwater constitutes about 95 per cent of the freshwater on our planet (discounting that locked in the polar ice caps), making it fundamental to human life and economic development. There are many reasons why society has found it so useful to develop groundwater, but among the most important are:

- Aquifers are very convenient sources of water because they are natural underground reservoirs and can have an enormous storage capacity, much greater than even the largest man-made reservoirs. For example, in the four decades up to the early 1980s an estimated 500 km3 of groundwater, equivalent to more than three times the total volume of either Lake Kariba or Lake Nasser, was withdrawn from the Ogalalla aquifer that underlies portions of eight states in central USA. Such storage enables timely use of water, which can be pumped out during dry periods when corresponding surface resources such as rivers or reservoirs may be unable to provide enough water; Many aquifers are also able to offer natural protection from contamination so untreated groundwater is usually cleaner and safer than its untreated surface water equivalent;
- Groundwater is relatively easy and cheap to use. It can be brought on-stream progressively with little capital outlay and boreholes can often be drilled close to where the water supply is needed;
- It is a resource that is organizationally easy to develop; individuals can construct, operate and control their own supply, often on their own land.

Globally, groundwater use is enormous, but it is generally recognized that the extent of its use tends to be underestimated, not least because the very ease and ubiquity of groundwater development means that much vital small-scale use is excluded from official statistics. Groundwater is often taken for granted by governments and society. The following sections merely give a flavor of its pivotal role in human development.

Groundwater in Cities

In the year 2000, twenty-three cities of the world had a population of more than 10 million, and are thus classed as *megacities*. Over half of these rely upon, or make significant use of, local groundwater (Table 1).

Estimated Population in 2000 A.D. (UNEP 1991; UNFPA 1991)

China alone has more than 500 cities, and two-thirds of the water supply for these is drawn from aquifers (Chéné, 1996). This high urban dependency is mirrored elsewhere in Asia and in Central and South America (Figure 1).

GROUNDWATER DEGRADATION PROBLEMS

Groundwater degradation occurs where there is

- Excessive exploitation, for example where groundwater levels fall too fast or to unacceptable levels. This not only reduces available water resources and borehole yields but can result in other serious and potentially costly side effects including saline intrusion and subsidence
- Inappropriate or uncontrolled activities at the land surface, including disposal of waste and spillage of chemicals, which contaminate the underlying aquifer. This can arise from diffuse sources, which results in widespread but generally less intense contamination, or from a point source, which causes more intense but localized problems;
- Major change of land use, for example in southern Australia, the removal of natural vegetation led to water logging and salinisation problems. The nature of the aquifer will also influence the scale of the contamination problem. Thus, in a highly fractured aquifer where groundwater flow is easy and relatively rapid, contamination may become more widely dispersed in a given time than where flow is inter granular, especially if the strata have only a modest permeability. Important issues when considering degradation are the use of water, the availability of alternative sources and the scale of impact on different users. Degradation of groundwater often affects the poor most, as they are least able to afford alternative water supplies or to cope with changes in livelihood that deterioration may force upon them.

GLOBALWATER CHALLENGES AND THE ROLE OF GROUNDWATER

Some striking challenges face those who are responsible for planning and managing the world’s water resources in the 21st century.

Population Pressure

Global population projections indicate that the world population will increase by 20 per cent from over 6 billion in 2000 to over 7 billion by 2015, and to 7.8 billion by 2025, a total increase of 30 per cent.

Urbanisation

Cities are growing at a very rapid rate worldwide. The current urban population of 2.8 billion people will increase to 3.8 billion in 2015 and to 4.5 billion in 2025.

Public Health

Water pollution is responsible for the death of some 25 million people each year, especially in developing countries. Half of the diseases that affect the world’s population are transmitted by or through water. Over 2.4 billion people have no acceptable means of sanitation, and more than 1 billion people draw their water from unsafe sources. In 1999, rural water supply coverage was still less than 70 per cent in Africa, Asia and in Central and South America; rural sanitation coverage extended to less than a third of rural households in these regions.

Per Capita Use

As and when water supply, sanitation and other aspects of the standard of living in the developing world improve, so per capita water use will increase. Although the water will not be consumed, its use will have a major effect on water demand and increase commensurately the quantity of waste water that is available for reuse.

Global Water Resources

The consumption of freshwater world wide rose six-fold between1900and 2000, more than twice the rate of population growth, and the rate of increase is still accelerating. The effect, when combined with the increase in population, will be to decrease globally the per capita availability of water resources. In Africa, for instance if we consider as an example the average per capita (per person) annual renewable water resource is predicted to decline by over 55 per cent between 1995 and 2025, from 5700 m^3 to 2500 m^3.

Agriculture Irrigated land now produces 40 per cent of the world's food, and two-thirds of the world's freshwater withdrawals are used by agriculture. This requires large supplies of water, for example 1000 tonnes of water are needed to grow one tonne of wheat. Salinisation of soils and groundwater is a major threat to water resource sustainability.

Industry Water use is certain to rise as the developing world expands its industry, which wasless than 15 per cent of world output in 1990.

Biodiversity In 1996, less than 7 per cent of the total land area of the globe received any form of protection for its flora and fauna.

OCCURRENCE AND MOVEMENT OF GROUNDWATER

Groundwater occurs in many different geological formations. Nearly all rocks in the upper part of the Earth's crust, whatever their type, origin or age, possess openings called pores or voids. In unconsolidated, granular materials the voids are the spaces between the grains), which may become reduced by compaction and cementation .In consolidated rocks, the only voids may be the fractures or fissures, which are generally restricted but may be enlarged by solution. The volume of water contained in the rock depends on the percentage of these openings or pores in a given volume of the rock, which is termed the porosity of the rock. More pore spaces result in higher porosity and more stored water. Typical porosity ranges for common geological materials are shown in Table 2.Only a part of the water contained in the fully-saturated pores can be abstracted and used. Under the influence of gravity when, for example, the water level falls, part of the water drains from the pores and part remains held by surface tension and molecular effects. The ratio of the volume of water that will drain under gravity from an initially saturated rock mass to the total volume of that rock (including the enclosed water) is defined as the specific yield of the material, and is usually expressed as a percentage.

STUDY AREA DESCRIPTION

Description of the Study Area

The Srinagar Municipal Corporation has at present only one Dumping Site at Syed-pooraAchan which comprises of 540 Kanals of land where the waste is being spread over and is further being covered with clay and use of disinfects are also being made. Over 20 years open dumping of the waste has been taking place .No proper land fill technique has been used till which causes bad effect on locality, ground water, local water bodies & the environment. Leachate from the waste pollutes the ground water there & lot of nuisance is therein the site. In fact some of the works have been taken up for execution by the J&K Economic Reconstruction Agency against the money released by the Asian Development Bank. All the environmental and other related issues will be redressed under the modernization plan. The modernization of

existing open dumping site into a scientific Sanitary Landfill site will be taken up for execution by the J&K ERA in a couple of months against the estimated cost of Rs. 22.00 Crores that will take care of all the pollutants including that of air quality, ground water quality and aesthetic look and landscaping of the interior of Landfill site as per guidelines of J&K SPCB.

Figure 1: Crude Dumping of Solid Wastes at Syedpora Srinagar Dumping Site

METHODOLOGY

Hierarchy of Processes for Checking Ground Water Quality near Dumping Site

To achieve this aim we go through these steps:

- Solid waste characteristics.
- Leachate characteristics.
- Leachate collection from the dumping site.
- Identification of wells or bore holes near the dumping site.
- Obtaining the ground water samples.
- Checking the quality of water samples.

Solid Waste Characterization

For characterizing municipal garbage, study can be carried out either by collecting samples from curbside or from garbage trucks arriving at a landfill. To assess the solid waste composition, samples were visualized from the truck discharge point to the dumping site. The samples were segregated into different categories viz. paper, wood, plastic, ceramics, glass, leaves, vegetables, textiles etc. The segregated samples were examined visually with extreme care. It consisted of organic waste, polythenes, paper, glass, leather, rubber, decayed Wood, dead animals, etc.

Figure 2: A Truck Carrying Solid Wastes from Srinagar City to Dumping Site

Solid Wastes Composition

The composition of composite solid waste sample is shown in the Figure below. From The Figure, it was found that the percentage of paper, textiles, plastic, metals and rubber were 5%, 8% , 12%, 0.2 % and 2 % respectively.

The vegetable and kitchen waste composition was high when compared to other portions of the solid waste and was found to be 72.8 %.

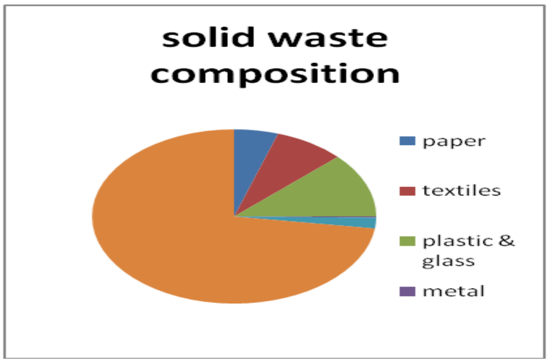

Figure 3

Identification of Wells or Bore Holes near the Dumping Site

To assess the quality of groundwater aquifers, the bore wells were chosen in the vicinity of the dumping site. Bore Well water was collected from five bore wells, which were located near the dumping site and a sample of leachate we also collected. Two wells were on upstream side and remaining three bore wells on downstream side. Well 1 and 2 were north of the dumping site and Well 3 and 4 in the east of the dumping site. Well 5 was bored at south of the dumping site. The water table is at an average depth of 8 to 9 feet from the ground level. The physical and chemical parameters like colour, odour, alkalinity, calcium, magnesium, sulphate content ,TDS, chloride hardness ,Ph were determined by analytical methods based on standard methods.

Well 1 and well 2 were at a distance of90meters and 250 meters away from the site.

Well 3 and well 4 were at a distance of 120 meters and 155 meters away from the site.

Well 5 was at a distance of 220 meters from the site

Depths of Bore Wells are as under

Well1 120 feet deep , well2 30 feet deep ,well3 20 feet deep ,well420 feet deep,Well520 feet deep respectively.

Methodology Adopted for Groundwater Sampling

Cutter penetrates the ground like a screw and boring is done .At the back of this cutter there is a slot which has a rings inside it for fitting into the pipe to it which depends on the depth of boring involved. Depending on the depth of boring, adequate shaft is chosen for the boring purpose. Across the shaft another bar has to be attached in transverse direction so that torque can be applied and thus the assembly is ready now for boring purposes.

After that with force, assembly is pushed into the ground and torque is applied across the shaft and boring continues. If the ground strata is very stiff the water can be sprinkled into bore hole so that ground becomes soft and with less effort boring can be done. Our depth of boring involved was 12 to 20 feet depending on the location of bore hole and ground strata was fairly soft. After boring was done casing pipe having a slit through it was driven into the bore well and water was pumped out for about half an day. After that samples of bore well water were taken from the site.

Testing and Water Quality Assessment

Table below shows the physical and chemical characteristics of the water samples collected from the various wells around the dumping site. These results were compared with IS 10500: 1991 for drinking water purpose.

The characteristics of dumping site leachate are also reported in. These high values measured in the underground water near the dumping site are an indication of its effect on groundwater. The major parameters tested in this study were hardness, chloride content, calcium, magnesium, sulphate content, total dissolved solids, alkalinity and Ph.

The range of chlorides concentrations in all the locations exceeded the permissible level described by IS 10500-1983. Chloride in reasonable concentration is not harmful, but it causes corrosion in concentrations above 250 mg/l, while at about 400 mg/l, it causes a salty taste in water.

Table 1: Results and Discussions Physiochemical Characteristics of Leachate and Ground Water

Parameters	Well 1	Well2	Well 3	Well 4	Well 5	Leachate	Requirement (Desirable Limit) as per IS 10500: 1991
pH	6.82	7.61	6.72	6.74	6.75	5.86	6.5 - 8.5
Total Dissolved Solids	620	410	1700	1050	1400	23000	500
Total Hardness (as CaCO3)	620	710	1580	1100	980	7100	300
Calcium (as Ca)	147	227	486	353	315	2425	75
Magnesium (as Mg)	53.5	115	230	225	152	1080	30
Alkalinity (as CaCO3)	840	510	1175	1400	1050	15000	200
Sulphate	505	765	1055	650	670	6600	250
Chlorides	63.9	102.95	1150.2	624.8	546.7	1272	250
True color	Colour- -less	Colour- -less	cloudy	cloudy	cloudy	grey	colourless
Odour	Odour - less	3g distinct grassy	3e Distinct Earthy	2e Faint earthy	3e Distinct earthy	Offensive	odourless

DISCUSSIONS

From the results it is noted that well 3 is highly polluted than other wells .After that its well 4 and well 5 that are highly polluted .It's because they are located on the downstream side of the site as indicated in the figure 3

Pollution of the wells depends on the following:

- Nearness of the well to the site. More the well near towards the site more will be it polluted.
- Secondly on its location whether its on downstream side or upstream side.
- Depth of the bore well. More the depth of well more clear will be the water**.**

Well1 and well 2 are less polluted because they are located on upstream side of the site.well1is least polluted because it is 150 feet deeper and located on upstream side of the site. The present mismanagement of the dumping site, which involves crude dumping, should be discontinued. The dumping site in its present condition creates a nuisance of odour, destroys the aesthetic nature of the environment and imperils water resources. Therefore properly designed containment type landfill facility is required to minimize ground water degradation in future.

CONCLUSIONS

The following observations can be made from the data presented with regard to the quality of underground water, and the effects of the syed - poraachan dumping site on the groundwater in the area of investigation.

- The water is non-potable because most of the physical and chemical parameters examined exceed the permissible limits for standard drinking water.
- Comparing the characteristics of each well, well 3 is highly polluted. This is expected because the well 3 is located just downstream of the solid waste dumping site. Ultimately, all results presented show that the syedporaachan dump site constitutes a serious threat to local aquifers.
- The present mismanagement of the dumping site, which involves crude dumping, should be discontinued. The dumping site in its present condition creates a nuisance of odour, destroys the aesthetic nature of the environment and imperils water resources. Therefore properly designed containment type landfill facility is required to minimize ground water degradation in future.

REFERENCES

1. Abu-Rukah Y. and Al-Kofahi O. (2001). The assessment of the effect of landfill leachate on ground- water quality – a case study, El-Akader Landfill site- north Jordan. *Journal of Arid Environments*.
2. Applied hydrology by Todd
3. Engineering hydrology by K. subramanya
4. IS-10500-1991
5. Kjeldsen p. (1993). Groundwater pollution source characterization of an old landfill. *Journal of hydrology.*
6. *Cgwb.gov.in*
7. The Assessment of the Effect of Dumping Site Leachate on Groundwater Quality-*S. Kanmani, R. Gandhimathi*